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From the Western Vascular Society

Superficialization of brachial artery as effective alternative vascular access

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Objective: **The Japanese Society for Dialysis Therapy recommends superficialization of the brachial artery (BA) as an alternative vascular access (VA) technique in patients for whom a conventional internal shunt (arteriovenous fistula [AVF] or arteriovenous graft) cannot be created. Although 2% to 3% of Japanese hemodialysis patients undergo this procedure, it is not well recognized worldwide. We report here our experience with the procedure, as well as indications, durability, and morbidity.**

Methods: **The technique involves exposure of the BA and ligation of the side branches, then fixing it beneath the skin at the upper arm. Cannulation of the BA is performed 2 weeks or more after surgery, and it is used as an outflow route, with any vein in an upper extremity utilized for blood return, including the hand if sites in the arm are not accessible. We retrospectively reviewed our cases of superficialization of the BA for VA.**

Results: **From 2005 through 2008, a total of 24 patients (11 females [46%]; average age, 69 years [range, 39-84 years]) underwent superficialization of the BA, of whom eight (33%) had diabetes. The indications were (1) impaired cardiac function (n = 13); (2) no other prospect for AVF or patient refused prosthetic graft implantation (n = 5); (3) severe upper extremity arterial disease or ischemic steal syndrome requiring AVF closure (n = 3); (4) venous hypertension with central vein occlusion (n = 2); and (5) repeated AVF thrombosis due to heparin-induced thrombocytopenia (n = 1). The mean follow-up period was 28 months. Serious complications were seen in one patient with an infected pseudoaneurysm formation associated with a BA puncture, which necessitated BA ligation, while two patients required an aneurysmectomy with reconstruction and one had occlusion of the superficialized BA, though no clinical symptoms of hand ischemia developed. We also had difficulty finding a vein for blood return in five patients. The rate of superficialized BA patency as a functioning VA was 95% and 66% at 1 and 3 years, respectively.**

Conclusions: **Superficialization of the BA was found to be a simple and safe technique, with acceptable durability and complication rate in selected Japanese hemodialysis patients. We consider that this shuntless VA permits adequate blood flow and has theoretical advantages for some patients, particularly those with impaired cardiac function, though the availability of a return vein is a prerequisite for a functioning VA. (J Vasc Surg 2014;59:1385-92.)**

A well-functioning vascular access (VA) is essential for efficient hemodialysis therapy, with several guidelines for better care presented. An autogenous arteriovenous fistula (AVF) is the most preferred method for a VA in terms of durability, complications, and total cost of maintenance as compared to a prosthetic arteriovenous graft (AVG) or central venous catheter.[1-6] Over 90% of such patients treated in Japan receive hemodialysis with an AVF, while an AVG is used in 7% and a permanent catheter in less than 2%.[7] However, there has been an increase in patients with comorbid conditions, including severe heart failure and advanced peripheral arterial disease, for whom it is difficult to create a conventional AVF or AVG. The Japanese Society for Dialysis Therapy published guidelines for VA in 2005 and revised them in 2011.[6,8] They recommend artery superficialization, including the brachial artery (BA) and femoral artery (FA), as an alternative VA technique for patients in whom a conventional AVF or AVG cannot be created, such as those with concomitant heart failure, VA-related severe ischemic steal syndrome, or venous hypertension with central vein occlusion. Although 2% to 3% of Japanese hemodialysis patients undergo this method, it is not recognized worldwide. We report here our experience with the procedure, as well as indications, durability, and morbidity.

METHODS

We reviewed our database of patients who underwent superficialization of the BA between January 2005 and December 2008. All of the operations were performed at a single hospital-based VA center in Osaka on an outpatient basis. Baseline demographic information as well as patient and VA characteristics were retrieved from clinical notes and the hospital electronic database. All complications, including pseudoaneurysm, thrombosis, infection, and ischemia, as well as subsequent treatments, were recorded. Primary outcome measures were patency of the BA as a functional VA following superficialization and patient survival. Functional VA patency was defined as a

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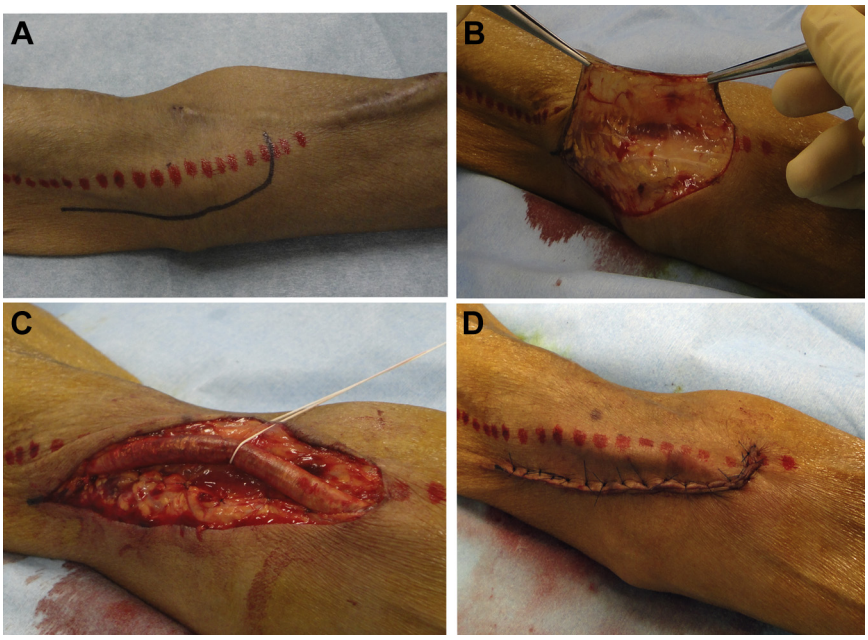

Fig 1. Details of the procedure. **A,** Hockey stick-shaped skin incision. **B,** Creation of skin flap. **C,** The brachial artery (BA) is isolated from its branches and subcutaneous tissue beneath the BA is sutured for superficialization. **D,** The skin flap is closed with interrupted sutures.

superficialized BA used as drawing site, and any venous return site was accessible. The indications for this procedure were based on the recommendations of The Japanese Society for Dialysis Therapy, with the following exclusion criteria: (1) no suitable vein for blood return; (2) BA diameter <3.0 mm; (3) circumferential calcification seen in X-ray images; (4) severe obesity; and (5) lack of patient agreement and/or poor patient cooperation. In addition to a physical examination, a preoperative ultrasound examination with a tourniquet placed was performed for all patients to verify robust veins for return sites, while the diameter, degree of atherosclerosis and calcification, and depth from the skin of the BA were also evaluated. No other imaging studies such as angiography were performed. There was no postoperative monitoring protocol, though problems such as difficulty with venous return, inadequate outflow, high venous pressure, and prolonged cannulation site bleeding led to physical and ultrasound examinations, followed by an appropriate intervention. The study was approved by the ethics committee of the hospital. All patients provided written informed consent.

Operative and cannulation techniques. Under local anesthesia with 1% lidocaine, a 10 to 15 cm hockey stick-shaped continuous skin incision was made on the medial aspect of the upper arm away from the BA to the antecubital fossa (Fig 1, *A*). Such extensive exposure was considered necessary in order to have a sufficient length of the BA for cannulation. After creation of a skin flap with subcutaneous fatty tissue below the dermis (Fig 1, *B*), the BA was identified by dividing the fibrous extensions of the biceps tendon, then opening the sheath surrounding the neurovascular bundle. The BA was dissected away from the adjacent veins and nerves, especially the median nerve, by ligating all side branches with 3-0 or 4-0 silk ties, and isolated. Subcutaneous tissue beneath the BA was closed with absorbable interrupted sutures, the BA was mobilized to the ventral aspect of the upper arm (Fig 1, *C*), and the skin flap was closed with interrupted sutures (Fig 1, *D*). It should be emphasized that thickness of the skin flap is a key with this procedure for easy cannulation and hemostasis, as skin erosion may occur with a thin flap, and cannulation will be difficult if the flap is too thick. Fig 2 shows a typical postoperative ultrasound image. The superficialized BA was cannulated using a 16- or 17-gauge needle (Supercath CLS; Medikit Co, Ltd, Tokyo, Japan; Fig 3) after the skin wound was completely healed (ie, 2 or more weeks after the procedure, which may require more than 1 month in frail patients, such as those affected by malnutrition). This was then used as an outflow route after meeting the hemodialysis requirements of the nephrologist at the individual dialysis unit (150-250 mL/minute for 4 hours, three times a week), with any vein in an upper extremity utilized for blood return, including the hand if sites in the arm were not accessible. Venous cannulation was performed using a 16- or 17-gauge needle. Fig 4 depicts several representative views of cannulation of the superficialized BA as well as the returning veins. As for cannulation of the superficialized BA, we paid attention to certain key points to minimize complications. First, at the initial cannulation, the puncture attempt was limited to a single attempt, because multiple

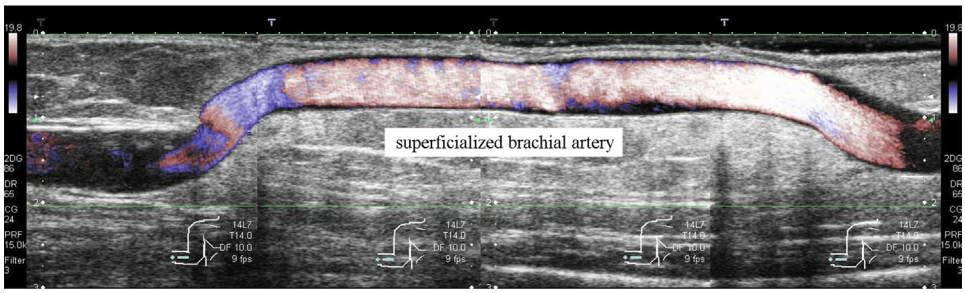

Fig 2. Representative duplex ultrasound image of a superficialized brachial artery (BA) obtained 3 months after the procedure showing appropriate subcutaneous tissue thickness.

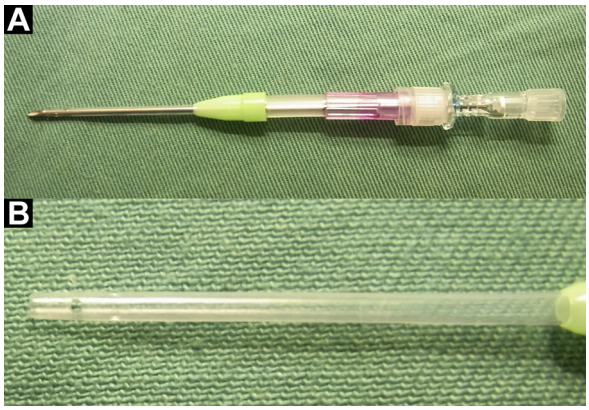

Fig 3. Cannulation system (16 G). **A,** Metallic needle encased in a catheter with side holes. **B,** Magnified view of catheter tip. Note the side holes to enable efficient blood drawing.

punctures are associated with inadequate hemostasis and might lead to pseudoaneurysm formation. The hemostasis procedure used was the same as that for sheath removal after an endovascular procedure. After needle withdrawal, it is important to compress the BA firmly for 5 to 10 minutes and then gradually reduce the pressure for another 10 minutes. Since the BA is located just beneath the skin, it was not a problem to correctly compress the puncture site. By repeated cannulation and hemostasis, the BA wall became thick and stabilized, which enabled easier cannulation and hemostasis, though modest aneurysmal changes were seen in most cases.

Statistical analysis. Values are expressed as the mean ± standard error or observed range. The Kaplan-Meier method was used to calculate cumulative patency rate and survival rate. Censored end points were death, loss to follow-up, and access survival at the last examination. Data were analyzed using the Excel (Microsoft, Redmond, Wash) and SPSS (SPSS Inc, Chicago, Ill) software packages.

RESULTS

From January 2005 to December 2008, 24 superficialized BAs were created in 24 patients, which represents 2.3% of all VA procedures for hemodialysis performed at our institution during that period. Demographic data are shown in the Table. The mean patient age was 69 years (range, 39-84 years), of whom 11 (46%) were women and eight (33%) were diabetic. Mean body mass index was 19.1 (range, 14.6-22.3), and there were no obese patients in this cohort. The mean duration of hemodialysis treatment before the procedure was 8.6 years (range, 0.1-30 years), and none of the patients underwent peritoneal dialysis prior to the procedure. All patients were followed for a mean period of 28 months (range, 1-77 months). Superficialization of the BA was performed only in selected cases, as described above. In 13 patients (54%), the indication was severe congestive heart failure (New York Heart Association class III-IV, ejection fraction [EF] <40%). In three patients (13%), superficial veins were available for AVF creation, though all patients suffered from advanced upper extremity arterial disease or ischemic steal syndrome requiring AVF closure. Two patients (8%) had a functioning AVF, but required AVF closure because of severe venous hypertension with central vein occlusion. Repeated AVF and AVG thrombosis due to heparin-induced thrombocytopenia was an indication for this procedure in one patient (4%). In addition, five patients (21%) who refused prosthetic graft implantation were indicated.

All patients tolerated the procedure well, and the mean operative time was 49 minutes (range, 25-85 minutes). The superficialized BA was punctured uneventfully without significant pain and provided a flow rate of 150 to 250 mL/minute, thus meeting the hemodialysis requirement of each patient. Two patients recovered from heart failure in whom an AVG was successfully created after 5 and 29 months, respectively. During the late postoperative period, aneurysmal change was seen in most cases because of repeated punctures in the short segment of the BA, though the superficialized BA remained functioning by changing the puncture site (Fig 4, *B*). As for serious complications, one patient had an infected pseudoaneurysm rupture, which necessitated BA ligation after 39 months, two patients required an aneurysmectomy with reconstruction of the BA after 30 and 72 months, respectively, and occlusion of the superficialized BA was observed in one

Fig 4. Representative views of superficialized brachial artery (BA) in use. **A,** The returning vein is the cephalic vein in the right upper arm. Modest aneurysmal changes of the superficialized BA can be seen. **B,** Both the vein and artery were cannulated with a 16-G needle (flow rate, 250 mL/minute; venous pressure, 100 mm Hg). This vascular access (VA) remained functioning for more than 4 years. **C,** No superficial veins were available and only the cephalic vein at the shoulder was used as a returning vein. **D,** Magnified view of returning vein (17-G needle; flow rate, 200 mL/minute; venous pressure, 100 mm Hg). **E,** Magnified view of superficialized BA. Modest aneurysmal changes were seen after 3 years of repeated cannulation (17-G needle; flow rate, 200 mL/minute).

Table. Baseline demographic and clinical data for 24 cases of superficialization of the brachial artery (BA)

No. of patients	24
Mean age, years (range)	69 (39-84)
Mean duration of hemodialysis, years (range)	8.6 (0.1-30)
Gender (male/female)	13/11
Body mass index (range)	19.1 (14.6-22.3)
Cause of end-stage renal disease	
Diabetes mellitus	8 (33%)
Chronic glomerulonephritis	5 (21%)
Hypertensive nephrosclerosis	2 (8%)
Unknown	9 (38%)
Comorbid conditions	
Heart failure	13 (54%)
Peripheral artery disease	10 (42%)
Coronary artery disease	8 (33%)
Hypercoagulability	1 (4%)

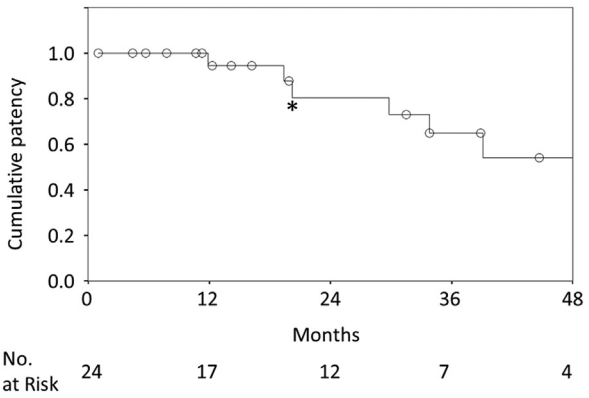

Fig 5. Cumulative functional vascular access (VA) patency rate for 24 superficialized brachial arteries (BAs) in the present study. *Standard error exceeded 10% at 20 months.

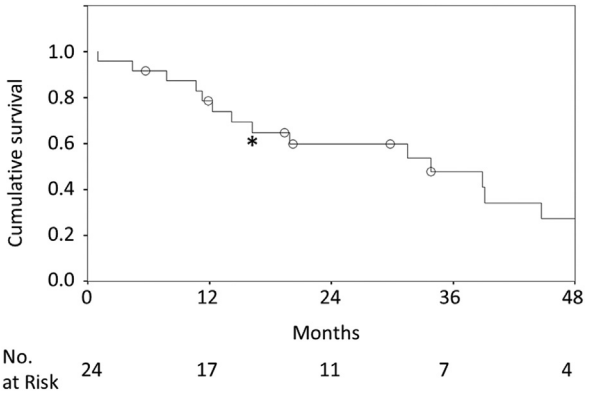

Fig 6. Cumulative survival rate for the 24 patients. *Standard error exceeded 10% at 16 months.

patient after 34 months, though no clinical symptoms of hand ischemia developed. No other complications such as interrupted blood flow to the hand, remote infection, or forearm compartment syndromes were observed. Another major complication was complete lack of a vein for return of blood, which was seen in five patients, including three who initially refused implantation of a prosthetic graft. Those three patients eventually accepted a prosthetic graft, while the other two underwent implantation of a central venous catheter. In contrast, if the patient had a robust vein (>2.5 mm), that was considered to be acceptable as a long-term return site, as the vein proximal to the access site will become dilated over time (Fig 4, *A*).

The rates of patency of the superficialized BA as a functioning VA were 95% and 66% after 1 and 3 years, respectively (Fig 5). Overall survival for all patients was 74% at 12 months and 60% at 24 months (Fig 6). During the study period, 14 patients (58%) died at a mean 20 months (range, 1.0 to 44 months) after the procedure. None of these deaths were related to the VA, and the superficialized BA remained patent as a functioning VA in all cases. The causes of death were heart failure (n = 4), sepsis due to pneumonia (n = 3), and unknown (n = 7).

DISCUSSION

The present results indicate that superficialization of the BA is a durable alternative VA that has acceptable complication rates in selected Japanese hemodialysis patients. The advantages of BA superficialization include simplicity and safety, quick use of the access (2 to 3 weeks after surgery), no maturation time, no recirculation, and lack of cardiac overload, thus indicating its theoretic suitability for patients with severe heart failure, as long as a robust return venous site is available. When there is a need to ligate a functioning AVF, such as in patients with venous hypertension with central vein occlusion or ischemic steal syndrome, this VA can be applied for such difficult cases. Venous hypertension is associated with a high flow rate (>3000 mL/minute of BA flow), and both arteries and veins are well dilated in this condition. Once superficialization of the BA is created after ligating the AVF, the superficialized BA as well as returning vein are easily accessed. The venous vascular bed is adequate for blood return and venous pressure should be less than 100 mm Hg at 200 to 250 mL/minute. Although our experience is limited to only two cases, we believe that venous pressure will not rise significantly even if the flow rate is greater than 400 mL/minute, because that is far less than that with an AVF in a patient with venous hypertension.

The patency rate of the superficialized BA as a functioning VA without revision in the present patients was satisfactory (95% at 1 year, 66% at 3 years) after considering their comorbid conditions. Since this autogenous shuntless VA has no maturation problems and stenosis of the BA over time is rare, postoperative surveillance is unnecessary, which contributes to lower cost as compared with a prosthetic graft or central venous catheter.[9]

Use of an artery as permanent VA for hemodialysis is not a new concept. Brittinger et al first reported a procedure to subcutaneously fix a superficial FA for a needle

puncture,[10] while superficial repositioning of the radial artery has also been reported.[11,12] In Japan, superficialization of the BA was originally developed as a backup method for a malfunctioning VA, while it is now used permanently in 2% to 3% of hemodialysis patients. Yasunaga et al presented the first English language report in Japan regarding superficialization of either the BA or FA in 1995.[13] Their main indications were hemodialysis patients with inappropriate veins, and frequent AVF or AVG failure. They reported a patency rate of superficially repositioned arteries of 87% at 3 years and mean survival time of 65 months. In our superficialized BA-provided series, 13 of the 24 procedures were performed in patients with severe heart failure to avoid cardiac overload, and the overall patient survival rate was limited to 60% at 24 months. In the present study, five were indicated for superficialization of the BA because of patient refusal of prosthetic graft implantation. This may occur only rarely in other countries. It is possible that Japanese hemodialysis patients are more likely to be concerned about the various complications associated with an AVG as compared with an AVF, which is being used in over 90% of hemodialysis patients in Japan. Superficialization of the BA was indicated for one patient with heparin-induced thrombocytopenia who had a history of multiple occurrences of AVF and AVG thrombotic occlusion, even though a direct thrombin inhibitor was administrated. Although a superficialized BA functioned as the drawing site for more than 4 years in this case, further study to confirm whether this type of VA is effective for patients with heparin-induced thrombocytopenia is needed.

Although cardiovascular disease including heart failure is highly prevalent and the leading cause of death in dialysis patients,[14-17] very few therapeutic options are available to prevent and treat its progression. Therefore, intractable clinical heart failure as an adverse effect from the VA should be considered as a possible contributing factor, even though the exact role of the VA in this morbidity is unclear. Heart failure is a complex clinical syndrome resulting from any structural or functional cardiac disorder that impairs the ability of the ventricle to fill with or eject blood. An EF <40% was adopted as the cutoff to define systolic dysfunction, though other factors such as diastolic dysfunction, cardiomyopathy, and ischemic heart disease should be considered prior to a diagnosis of heart failure. The causes of congestive heart failure in the present patients were heterogeneous, as some had EF <30%, while others had an EF of 40% but with concomitant severe valvular heart disease or cardiomyopathy also observed. All these heart failure cases were diagnosed as New York Heart Association functional class III-IV. A tunneled central venous catheter is generally used in patients with severe heart disease for long-term dialysis. The percentage of patients using a catheter has increased in most countries in recent years, even though tunneled central venous catheters are prone to infection, stenosis, and thrombosis of the central veins, and are not considered to represent an acceptable long-term alternative.[2,18] These issues further support the role of the present VA procedure. On the other hand, our shuntless VA has certain drawbacks, because it requires recurrent cannulation of the short segment of the BA, and the veins available for return are limited, which can lead to substantial complications, such as prolonged puncture site bleeding, arterial aneurysm, pseudoaneurysm, stenosis, and thrombosis.

In our series, we encountered three cases with enlarging aneurysms that required surgical repair, including rupture of an infected pseudoaneurysm. All of these complications were associated with inappropriate hemostasis. Special attention should be paid at the initial cannulation, as previously described. Multiple attempts at an initial cannulation may lead to inappropriate hemostasis as well as pseudoaneurysm formation, though no such complications were observed in the present patients. The superficialized BA gradually stabilized, and modest aneurysmal changes were seen over time in most of our cases, while serious complications were rare. Close cooperation with nephrologists and the dialysis staff with the unique characteristics of this particular VA in mind is also essential to prevent serious complications. Since the superficialized BA will not become enhanced over time, the recommended diameter is greater than 4 mm, and the procedure should not be indicated if that diameter is less than 3 mm because of difficulty with cannulation. In addition, a unique VA cannulation system is available for use in Japan, in which the metallic needle is encased in a catheter with multiple side holes. This needle is soft and flexible, thus it might be less traumatic to the vessel wall and may have contributed to our favorable outcomes. Occlusion of the BA may lead to distal ischemia and requires immediate salvage. In our patients, we noted that occlusion or ligation of the BA was well tolerated because of sufficient collateral flow. However, arterial reconstruction may be necessary in patients with advanced peripheral arterial disease. In cases with complete lack of a returning vein, this VA should be abandoned and a tunneled central venous catheter is indicated. Those cases are rare exceptions in Japan, with only 2% of dialysis patients using such a catheter, a striking difference as compared with the United States, Canada, and the United Kingdom, where catheter use is at least 23%.[7] Although the reasons for this difference are not clear, we postulate that they are related, at least in part, to the prevalence and degree of obesity. In our series, none of the patients were obese, and the mean body mass index was 19.1, which might account for our high success rate of the superficialized BA as a functioning VA and low rate of central venous catheter usage. We also speculate that dialysis is offered to patients in the United States with more advanced age and comorbidity as compared with Japanese dialysis patients.

In the present study, the superficialized BA provided sufficient dialysis blood flow (150-250 mL/minute) in all cases, though it should be noted that the median blood flow required at initiation of hemodialysis varies widely among various countries (300, 250, 200, and 160 mL/minute in the United States, the United Kingdom, Germany, and Japan, respectively).[19] It has been reported

that a 16-gauge needle can provide a flow rate greater than 300 mL/minute, thus this VA may be applicable in other countries in addition to Japan.[20] A number of new approaches for autogenous VA for patients with a difficult access extremity, including basilic vein transposition,[21] femoral vein transposition,[22,23] and brachial vein transposition,[24] have been reported. However, we consider that these procedures are extensive as compared with the present method and can be performed only in individuals without significant comorbidity. Therefore, we believe that the utility of our method for use of a superficialized BA as a VA can be extended worldwide for treatment of appropriately selected patients.

Limitations of this study include its retrospective design and data obtained from a single institute. Diagnosis of heart failure in dialysis patients can be difficult, because it may coexist with volume overload. Also, patient selection may be biased by the preference of the VA surgeon, patient comorbidities, and other unmeasured yet potentially important confounders.

CONCLUSIONS

Superficialization of the BA was found to be a simple and safe technique, with acceptable durability and rate of complications in selected Japanese hemodialysis patients. We consider that this shuntless VA permits adequate blood flow and has theoretical advantages for some patients, particularly those with impaired cardiac function, though the availability of a return vein is a prerequisite for a functioning VA.

AUTHOR CONTRIBUTIONS

Conception and design: TN, JN
Analysis and interpretation: TN, JN
Data collection: TN, KS, JN
Writing the article: TN, KS, JN
Critical revision of the article: TN, JN
Final approval of the article: TN, KS, JN
Statistical analysis: TN, JN
Obtained funding: Not applicable
Overall responsibility: TN

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DISCUSSION

Dr Nicolas A. Nelken (*Honolulu, Hawaii*). One of the great things about reviewing a paper from another country is trying to make sense of the differences in practice. Two to three percent of Japanese dialysis patients undergo a procedure most of us have never even heard of. That's almost 9000 patients.

Are the differences historical, cultural, or physiological? Historical? Is this just a geographical product of the "see one, do one, teach one" tradition in spite of worldwide instantaneous access to information? Is it cultural? From the patient point of view, it is highly unlikely that any patient would demand this over a graft in my practice. Or from the doctor's point of view, it is unlikely that we would choose this procedure for an ejection fraction of 40%, might be more likely at 30%, and would be a good idea to explore at 25%. Or is it physiologic differences between populations? I had to laugh when I read that the average body mass index (BMI) of Dr Nakamura's patients was 19.1. We don't even operate in the same universe! That's not Japan… that's Heaven!

So I think this new procedure shows promise, but… how do we make sense of this for ourselves?

Let's look at the individual indications from least likely to be helpful to the most. I think it makes little sense to use this for patients with poor peripheral venous anatomy. If you can't find a vein for a fistula, how will you find a vein for outflow? It makes a little more sense to explore for those patients with congestive heart failure. I'm just not sure of the threshold. I'm yet more interested for patients with central venous occlusion. The most interesting indication for me is for steal syndrome. Since we've already failed and endangered the nondominant hand, it is good to know we have another procedure to try before risking and jumping to the dominant hand.

So, with this in mind, I have the following questions to help resolve this: (1) At what BMI should we forget about it? Or is this a depth issue that can be measured with ultrasound? (2) How do patients tolerate the outflow during 4-hour dialysis runs when they have central obstruction? (3) And finally, in my opinion, the weak link in dialysis access care in America is at the technician level. With a 4-year arterial failure rate of 40%, please excuse me from being a little nervous. What can you tell me to allay my fears?

Dr Takashi Nakamura. Dr Nelken, thank you for your thoughtful comments.

I would like to address your questions about BMI and the depth of the artery. Data from the OECD (Organization for Economic Cooperation and Development) show that individuals with a BMI over 25, which is considered to be obese, comprise only 3% of the population in Japan as compared to 35% in the U.S. Therefore, even though our cohort is thin, it is not an unusual representation in Japan.

Prior to surgery, we estimate the depth and elasticity of the brachial artery in a physical examination and then perform an ultrasound examination with a tourniquet placed to verify the existence of robust veins for return sites. In addition, we also evaluate the brachial artery for diameter, degree of atherosclerosis, degree of calcification, and anatomical variations, such as highly bifurcated type or not and depth from the skin. We have not determined exact criteria for depth because we rarely encounter obese patients. To apply our method in obese patients, I would recommend a lipectomy with a longer incision, which might create enough length for cannulation, though I have not attempted that.

As for venous hypertension with central vein occlusion, it is basically associated with a high blood flow state, over 3000 to 4000 mL/min, which eventually requires banding or ligation of the arteriovenous fistula. However, if superficialization of the brachial artery is performed, the dilated artery as well as the dilated returning vein can still be used as access sites. During a dialysis session, average blood flow is kept lower than 250 mL/min in Japan, which is far less than with a patent arteriovenous fistula. In fact, venous pressure is constantly lower than 150 mm Hg; thus, central venous occlusion is not a problem. Furthermore, even if blood flow is increased to 400 mL/min, I don't think that venous hypertension during a dialysis session will be a problem.

Close cooperation among the attending nephrologists and dialysis staff regarding the unique characteristics of this particular vascular access (VA) is essential to prevent serious complications. Local hematoma formation or a minor infection at the site of puncture related to inappropriate hemostasis by inexperienced personnel should be avoided. I am sure that you will understand how our method works after you attempt it. In fact, this VA has been utilized in appropriately selected Japanese hemodialysis patients for more than 20 years with very satisfactory results.

Finally, a tunneled central venous catheter is generally used in patients with severe heart disease for long-term dialysis. The percentage of patients using a catheter has increased in most countries in recent years, even though tunneled central venous catheters are prone to infection, stenosis, and thrombosis of the central veins, and are not considered to represent an acceptable long-term alternative. Therefore, I recommend that this VA be considered before indwelling central venous catheters.